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Division of Forest Insect Investigations

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SUBJECT—

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FOREST INSECT
LABORATORY

2. The effectiveness of DDT as an insecticide against gypsy moth larvae.

Four (4) one acre plots, two (2) one-half acre plots and a group of 5 willow trees and 12 apple trees were treated with DDT using ground equipment. The insecticide was applied as an emulsion[1] on all except one plot where it was mixed as a suspension.[2] When applied as an emulsion at the rate of 3 pounds and also at the rate of 1 pound per 100 gallons of water practically complete control resulted on all plots whether the insecticide was applied before hatching took place or when larvae were in the fourth or the fifth stage. In fact the only survival recorded was on the group of willow and apple trees where six new egg clusters were found in the fall. These trees were treated prior to larval hatch. Due to their protected position many egg clusters did not hatch until at least two weeks after the spray was applied, and it is presumed that by that time there had been a loss in the residual toxicity of the insecticide. Complete control was obtained on a one acre plot of woodland sprayed just prior to larval hatch. When DDT was applied as a suspension there was considerable survival of gypsy moth larvae. On the one plot treated in this manner the insecticide was applied at the rate of 3 pounds per 100 gallons of water just prior to larval hatch.

Two areas were treated with DDT applied from an airplane and complete control was effected on each of them. One area of 20 acres at Jefferson, Pa., was treated just prior to larval hatch with an oil spray[3] containing 1 pound of DDT per gallon of liquid. It was applied as a fine mist at the rate of 5 gallons per acre. The second area was a 5 acre plot at Greenfield, N.Y. It was treated with the same solution. Gypsy moth larvae were in the second and third stages and the trees were well foliated at the time of application.

3. The effectiveness of lead arsenate, cyrolite and DDT when applied from an airplane.

During the winter of 1943-1944 the Division of Gypsy and Brown-tail Moths Control perfected a spinner-disk apparatus suitable for distributing concentrated sprays from a White Standard Biplane. A number of areas in Pennsylvania were treated with this plane, and one acre plots laid out within these areas served as a check on results. Plots on which cryolite at different dosages and lead arsenate were applied showed some excellent reductions in gypsy moth population, but control was incomplete on all of them. The sprays were deposited as fine droplets which in general adhered well

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[1]The stock emulsion contained DDT, cyclohexanone, Shell Oil, Alcohol and an emulsifying compound. It was emulsified when poured into the spray tank of water.

[2]The suspension was mixed dry using 1 part DDT and $\frac{1}{8}$ part Urea Resin Glue (Weldwood), a small amount of water was added gradually to form a slurry which was poured into the spray tank.

[3]Mixed as follows in parts per weight: DDT, 1; Cyclohexanone, 1; Shell Horticultural spray base "heavy" oil, 7.

to the leaves. Some "dusting", i.e., drying of particles as they fell so that they were deposited as a dust, was observed when the relative humidity of the atmosphere was comparatively low. This was particularly true of the cryolite concentrate made up using the Karr formula. The concentrate made up using the Potts formula was considered superior, because it was somewhat more fluid. Coverage of exposed leaves was excellent. Coverage of leaves in the lower part of the crown and on the underbrush depended largely on density of the canopy. Where openings occurred coverage was often good right to the ground, but if the canopy was dense the lower leaves often had little or no spray deposited on them.

Plots treated with DDT by an airplane have been referred to earlier.

4. The toxicity of micronized scorodite and potassium fluosilicate on the gypsy moth larvae.

Very brief tests were made of these insecticides. Each was mixed at the rate of 5 pounds per 100 gallons of water and the solutions were sprayed on low growth oak with an Indian Fire Pump sprayer equipped with a mist nozzle. The sprayed foliage was fed to fifth stage gypsy moth larvae in trays. After 23 days only 17 out of 50 larvae fed foliage sprayed with micronized scorodite and only 22 out of 50 larvae fed foliage sprayed with potassium fluosilicate had died.

C. Status of the work on this project.

Sprays applied from the ground.

It is believed that some further investigation should be conducted in 1945 in order to work out the proper dosage of lead arsenate to use against the gypsy moth in the type of growth used for experimental plots in 1944. Some of the 1944 plots could be used another season to good advantage and with very little cost in time or labor.

It would be highly desirable to treat some plots with very light dosages of DDT mixed as an economical emulsion. The lowest practical dosage of DDT should be determined. Some investigations should be conducted regarding the timing of the spray application particularly in an effort to determine whether the treatment of undergrowth and trunks of trees previous to larval hatch would provide an adequate measure of control.

Sprays applied from aircraft.

The application of DDT from aircraft shows such promise in the control of the gypsy moth that as much time as possible should be devoted to this phase of the problem. Dosage, timing and formulation all require a great deal of careful investigation.

There will not be enough DDT available in 1945 to treat a considerable portion of the area infested by the gypsy moth in Pennsylvania. It is therefore planned to treat considerable acreage with cryolite. A satisfactory formula for mixing synthetic cryolite for use from an airplane must be worked out, and checks should be made on control obtained on treated areas.

5. Insecticidal investigations. (Potts)

A. General conditions affecting completion of program.

The writer was transferred to the smoke aerosol project at Beltsville, Maryland about the middle of January and spent most of his time on that project until June 30. During May and June about 20 field tests with DDT mixtures applied as dust, dilute spray, and concentrated spray were made at North Haven, Conn., Hamden, Conn., and Sandwich, Mass. About 50 laboratory toxicity tests were made using both laboratory and field treated material. The principal insects concerned were the gypsy moth and cankerworms. From July to October the assignment was at Beltsville, Md., on the development of DDT concentrated spray mixtures, where 50 1/30-acre plots of deciduous growth 4 to 6 feet high were treated, 42 with concentrated spray and 8 with dilute spray. In September part of the work was with others from the New Haven Station in applying DDT concentrates to 10 plots treated from the air in Connecticut and Massachusetts cooperatively with the Gypsy and Brown-tail Moths Control Division. In November, 20 small plantation plots consisting of white pine, hemlock, and spruce were sprayed with 17 concentrated spray mixtures and 3 dilute spray mixtures, all containing DDT. A few laboratory tests were made by caging white pine weevils and pales weevils with sprayed leaders from the plots. During October and November records were made of the degree of weevil control by concentrated spray in 17 plantations treated from 1940 to 1944 at Petersham, Mass., Eastford, Conn., and North Branford, Conn. During the same period data on growth measurements, infestation records, and various physiological data were taken at Petersham, Mass., in silvicultural plots designed to furnish information on controlling the weevil by natural means.

B. Progress during calendar year.

(a) Smoke Aerosol project.

This work was done at Beltsville, Md., and in New England. It was under the direction of Randall Latta of the Division of Control Investigations. Work at Beltsville was by R. Latta, S. F. Potts, T. E. Bronson, and F. W. Poos, and in New England by Latta and Potts. The equipment was built in Beltsville where over 200 biological tests were made, mostly with greenhouse and truck crop pests. Twenty different insect species were included in the smoke tests. The smoke was in liquid form. It was generated by spraying concentrated spray on metal surfaces heated to 600 to 1,000° F. or by propelling it with steam from coils heated to about 900° F. Insects tested in the field included the pea aphid, Macrosiphum pisi (Kalt.), clover leaf weevile, Hypera punctata (F.), gypsy moth, Porthatria dispar (L.), forest tent caterpillar, Malacosoma disstria Hbn., Eastern tent caterpillar, Malacosoma americana L. and cankerworms, Paleacrita vernata (Peck) and Alsophila pometaria Harr. The gypsy moth was the most susceptible species to DDT application. When 5½ gallons of concentrate containing 8 pounds of DDT was applied to woods heavily infested with the gypsy moth, control on one-third acre resulted for a period of 4 or 5 weeks.

Insecticides applied were rotenone extracts, pyrethrum extract, nicotine in various forms, and DDT.

A great deal of useful information on particle size and methods of measuring particle or droplet size was amassed. Extremely small particle sizes (as 0.3 to 20 microns) were not effective against insects except when the smoke plume contained atomized spray droplets that had not been broken up into smoke size. Attempts to coalesce the small smoke droplets into droplets large enough to be highly effective was not successful. Direct atomization of the concentrate to the proper droplet size by mechanical means (both solutions and suspensions) or by liquefied gas (solutions only) appears to be the simplest and most practical method of application.

Insect mortality depended on obtaining a deposit on the insects and plants. If the smoke passes over the insects and plants without depositing no mortality results. Droplets of a given size applied by liquefied gas gave the same mortality as droplets of the same size applied by mechanical atomization.

Two special reports have been submitted by the above workers in the form of 27 typed pages of text and 11 figures.

(b) Tests of DDT concentrates against the pea aphid and the clover leaf weevil.

Of special significance are three concentrated spray tests made at Beltsville, Md. for control of the pea aphid and clover leaf weevil on moderately heavy infested alfalfa. The tests were made by S. F. Potts, T. E. Bronson and F. W. Poos. In one test a quart-sized hand atomizer was used to apply a concentrate containing 20% DDT, 20% cyclohexanone, 30% lubricating oil (SAE 10) and 30% No. 2 fuel oil to a one-tenth acre plot. Application, which required 20 minutes, was at the rate of 1.3 gallons (2.4 pounds DDT) per acre. On the basis of volume the average drop size was about 60 microns diameter. Ninety-nine to 100% kill of aphids resulted and 17 days after treatment the aphid infestation in the treated plot was only 1% of that in the check, thus indicating residual effect unlike ordinary contact insecticides. A light infestation of clover leaf weevils was wiped out.

In two other plots the equipment consisted of a 3/4 hp gasoline engine, single cylinder compressor, two-gallon aluminum tank with constant pressure regulating valve, and 3 air-atomizing nozzles. In one plot the mixture consisted of 20% DDT, 20% cyclohexanone, 45% kerosene and 15% No. 10 motor oil. Application was at the rate of 6 3/4 quarts per hour and 2¼ quarts was applied in 20 minutes. The equipment was kept at one location at one side of the field and the atomized concentrate drifted across it with the aid of a 5 to 10 mile wind. A 90 to 100 percent kill of aphids and weevil larvae occurred for a distance of 200 feet from the atomizer, and there was a kill of about 80% as a distance of 250 feet. Good control was observed over an area of about one-half acre and some control over an additional half acre.

In the other test the same equipment was used to atomize 1 1/3 pints of concentrate containing 10% DDT, 10% cyclohexanone, 55% kerosene, 15% motor oil and enough pyrethrum extract to make 0.1 pyrethrins. Control of the pea aphid was 90 to 100% for the first 200 feet, over 50% at 250 feet, and over 40% at 300 feet, respectively, from the atomizer. A light wind aided in covering one-third acre with 1 1/3 pints of concentrate at the rate of one-half gallon (0.4 pound DDT) per acre. Average particle size in this and the preceding test was about 45 to 55 microns.

In a preliminary test a concentrate containing 1/3 pound DDT, 1 1/3 ounces motor oil, and 7 3/4 pints kerosene, was applied with an atomizer with good results. This mixture costs only 35 cents per gallon. These results, together with others obtained previously by the writer, suggest the possibility of using lightweight portable atomizing machines with a strong blower to aid in drifting of finely atomized spray to cover swaths of from 100 to 200 feet of truck and hay crops. Also, many heretofore uncontrolled insects might be controlled on such crops by covering large acreages rapidly, cheaply, and without too much damage from the machines themselves.

A manuscript on the above tests has been prepared by F. W. Poos, S. F. Potts, T. E. Bronson and R. Latta.

(c) Development of DDT concentrated spray mixtures.

These studies were to develop concentrates that will remain effective for 4 to 8 weeks. In addition, mixtures should be relatively inexpensive and should occasion no breakdown of DDT nor cause foliage injury. The ingredients should be cheap, readily obtainable, and easy to mix.

Part of the studies were made in New England but over half of it was done at Beltsville, Md. between July 1 and October 1. The work at Beltsville was in cooperation with the Division of Insecticide Investigations, which made analysis of leaf collections from the plots before and after rains to determine adherence of residues. To determine effectiveness, biological tests were made using whatever insects were available at the time and place of study. Results of tests of certain of the mixtures against various insects are discussed elsewhere in the progress report.

At Beltsville the Japanese beetle was the test insect in most cases. They were caged in quart and half-gallon fruit jars containing the following from plots: (1) Sprayed twigs and bark plus sufficient unsprayed foliage to keep the beetles from becoming hungry, (2) dried, sprayed foliage plus sufficient fresh unsprayed foliage to supply their needs, and (3) fresh sprayed foliage. When the first series of 20 plots was treated the number of beetles counted per plot ranged from 42 to 173. The growth was mostly deciduous sprout 4 to 7 feet tall. The plots were one-thirtieth of an acre in area. Application was at the rate of 3 gallons per acre giving an average of about 3 pounds of DDT per acre.

Mixtures were prepared in the form of (1) solutions, with solvents or solvents and oil as the carrier, (2) emulsions with water as the carrier, (3) suspensions containing bentonite as a suspending agent with water as the carrier, and (4) suspensions containing oil as the carrier. All of the above mixtures were prepared with and without a drying oil (as linseed oil) as an adhesive. Some mixtures were prepared containing casein as the adhesive. These adhesives greatly increased the adherence of suspensions. When using adhesives 0.2 to 0.3 pint of drying oil or 0.1 pound of casein or Casco glue (not calcium caseinate) should be added per pound of solids added to the mixture. Solutions containing oils that volatilize after reaching the foliage (such as kerosene) adhere well without the addition of an adhesive. The presence of more than 0.4 pint of non-drying oil per pound of DDT tends to prevent crystallization and greatly reduces the effective residue deposit after exposure to rain. For immediate contact effect on foliage non-volatile, non-drying DDT solutions were more effective than rapidly and completely volatilizing solutions, but the former is not effective over a long period of time when exposed to weathering.

Xylene and benzene were relatively cheap solvents and kerosene was a relatively cheap carrier for solutions. In the case of emulsions a quantity of Triton X-100 or B 1956 was added equal to one-fifteenth of the volume of solvent and oil in the mixture. Emulsions should contain a small quantity of oil (usually 0.2 to 0.3 pint of oil per pound of DDT) to prevent complete evaporation and drying of small droplets before they reach the foliage.

There has been much speculation and many opinions have been expressed on the relative merits of solutions, emulsions, and suspensions. Under certain conditions each type of mixture is superior. Solutions and properly prepared emulsions are about equally effective. Solutions are somewhat more preferable for airplane application. However, if oil carriers are not accessible or if there are serious transportation difficulties emulsions may be preferable to solutions.

Mixtures containing as high as 6 pounds of DDT per gallon were prepared. It is not likely that such high concentrations will be applied in the field but high concentrations could be shipped to avoid excessive transportation costs and then diluted in the field.

All mixtures gave complete kill of Japanese beetles at time of treatment but those containing more than one-half pint of non-drying oil were not completely effective after 12 days weathering. Most of the other mixtures were effective for the entire season. Beetles on fresh sprayed foliage, dried sprayed foliage, and twigs from the plots were susceptible in the order given. Foliage taken from the concentrated spray plots as well as dilute spray application of one-fourth pound of DDT per 100 gallons of water were effective against the fall webworm.

Very satisfactory mixtures have been developed for the coming season. However, such additional information can be gotten from further studies of mixtures.

(d) Test of DDT mixtures for control of the gypsy moth.

In ground spray plots of sprout growth heavily infested with fourth, fifth, and sixth instar gypsy moth larvae complete kill was obtained with dilute spray emulsions at DDT concentrations of 1-3000, 1-6000, and 1-12,000. When applied as a concentrated spray at the rate of 1.25, and 0.64 pound respectively of DDT in 2 gallons of mixture per acre complete kill resulted. Apparently 0.33 pound of DDT in 1 gallon of mixture per acre also gave complete kill. A dust treatment at 20 pounds per acre of 10% DDT was not effective. In the laboratory dilutions up to 1-36,000 were completely effective as a stomach poison; dilutions up to 1-250 were effective on twigs; and dilutions up to 1-1000 were completely effective when applied to the body as a contact spray.

Mixtures applies to the concentrated spray plots contained per gallon 0.8 pound DDT, 1.5 pints benzene, 1 pint paraffin oil and 5.5 pints of kerosene for the 1.25 pound dosage and 0.33 pound DDT, 0.66 pint paraffin oil, and 7.3 pints kerosene for the 0.64 pound dosage. It is thought that the considerable quantity of paraffin oil in the mixture reduced the adhesion of the deposit and prevented the formation of crystals. The results also indicate that one or two gallons per acre of kerosene containing 3 to 5% DDT dissolved in it might give good economic control of gypsy moth larvae. Tests made prior to and after the above tests indicate that a small quantity of drying and non-drying oil not greater than 0.3 of the weight of the DDT, increases adhesion. Mixtures containing 3 to 5% DDT can be prepared at a cost of 30 to 40 cents per gallon, figuring the cost of DDT at 75 cents per pound.

June beetles, black flies, mosquitoes, crane flies, and forest tent caterpillars, were susceptible to DDT in about the order given.

Some additional improvements were made in cryolite and lead arsenate concentrated spray formulae by using a combination wetting and suspending agent (Daxad No. 11 and Daxad No. 14) in place of regular wetting agent such as Santomerse D or S. The rexform and Grassalli lead arsenate gave by far the greatest fluidity at the highest lead arsenate concentration of all the brands tested. For future work it would be very advantageous to purchase either of these two brands in preference to other brands.

(e) Test of DDT mixtures for control of cankerworms and aphids.

Cankerworms were controlled in plots of low sprout growth with one pound of DDT in 100 gallons of dilute spray emulsion or with 3 pounds of DDT in 3 gallons per acre of finely atomized concentrate. Preliminary tests of lower dosages indicated that they were much less effective. DDT was more toxic to cankerworms as a stomach poison than as a contact poison.

Against aphids (probably Kuceraphis mucidus (Fitch) on black birch 3 pounds of DDT in 3 gallons of concentrate per acre was effective, the results being better than 3 pounds of DDT in 1 gallon of concentrate per acre, due to more complete coverage in case of the former gallonage.

A concentrated spray formula consisting of 1 pound DDT, 2 pints xylene or benzene, 2.8 pints kerosene and 3 pints motor oil was more effective as a contact spray against aphids than a mixture consisting of 1 pound DDT, 2 pints xylene or benzene, and 5.8 pints of kerosene with and without 4 ounces of linseed oil. However, the latter formula gave good control of leaf-eating insects over a period several times as long as for the former.

(f) Application of the concentrated spray method for control of other than forest insects.

Although very few ground and serial distributing devices are yet available, the method has already been of considerable value. For example, as a result of demonstrations in 1936 and 1937 at the Morristown National Park and at Whitesbog, N.J., the Seabrook Farms Corporation made 5 or 6, six and eight-row power atomizers, and distributing devices for 3 airplanes, now used for treating their 15,000-acre truck farm. They report the method has already saved them at least a million dollars in profits and increased production. Since 1938 New York pea canners have been using concentrated spray solutions of nicotine, and rotenone extract for effective pea aphid control. Through cooperation with the White-fringed Beetle Control unit, two types of large power atomizers were developed by them in 1941. C. N. Husman who worked with the writer in 1940 on concentrated spray equipment developed in 1943 an aerial spraying unit for the Division of Insects Affecting Man and Animals. As a result of this work that Division and the Army and Navy are contemplating making extensive use of the method for control of mosquitoes, flies and other obnoxious forms. The Canadian and British Governments are also planning to use the method during the coming season.

(g) Control of the white pine weevil by the application of concentrated sprays.

The work is in cooperation with the New York Conservation Department, Professor Ralph Hawley of the Yale Forest School, the Connecticut State Department of Forestry, and the Harvard Forest at Petersham, Mass. In New England about 20 sprayed plantations are under observation. In North Branford, Conn., a plan is under way to treat practically all the pines in a large section of a town in order to prevent reinfestation and make one treatment do for the life of the stand. No part of a stand is left untreated.

Additional plantations were treated with lead arsenate concentrate on the New Haven Water Company property by Professor Hawley. About 60 acres have now been sprayed in this area. David Crosby assisted in this work and directed the spraying operation in the writer's absence. Infestation records taken in October show that if the whole of stands are treated, one and at the most two, thorough applications will serve to protect the trees during the life of the stand, whereas if only part of a heavily infested stand is treated, reinfestation will make it necessary to spray 2 or 3 times for protection of the first log.

Further applications should be made to untreated areas on the New Haven Water Company until the whole property is covered. Observations on other treated plantations and checks in New England should continue. DDT tests with hand and small power equipment should be made in New England and New York. Airplane applications of DDT concentrate should be made to heavily infested plantings in New York.

C. Status of the work.

No further work with smoke is contemplated for 1945. A few tests using liquefied gas aerosols are contemplated. A special effort will be made to develop suitable atomizing equipment for applying finely atomized spray to tall trees, and for drifting the atomized spray into plantations and woodlands from considerable distance. Various types of nozzles will be investigated.

Further studies of DDT and other insecticidal mixtures should be made. Toxicity and physiological tests on various forest and shade tree insects are anticipated.

Large field plots and numerous small field plots will be treated from the ground with atomized spray for control of the gypsy moth, cankerworms, elm leaf beetle, European pine shoot moth and white pine weevil. About 100 acres will be treated from the air for control of the white pine weevil.

Particle size studies should be continued.

6. The study of insects affecting forest plantings and areas of natural reproduction and the development of silvicultural methods of control.

Sawfly investigations. (Schaffner)

A. General conditions affecting completion of program.

No extensive surveys were made during 1944 because of the shortage of man power and the restrictions on transportation. Studies were continued in some of the areas known to be severely infested, and they consisted largely in attempting to develop economical means of controlling the red-headed pine sawfly (Neodiprion lecontei (Fitch), which has been causing serious damage for the past several years in young forest plantations of jack pine and red pine throughout most of northern New York. Some studies were also continued in serious infestations of Diprion frutetorum (F.) in red pine plantations in Connecticut and of the red pine sawfly (Neodiprion n. sp.) in a natural stand of red pine near Ausable Forks, N. Y.

B. Progress during calendar year.

Neodiprion lecontei (Fitch).

These studies were carried on in cooperation with the New York Conservation Department and most of the work was done in 6 to 10 year old plantations of red pine on State Forests in Brasher Township, St. Lawrence County. Messrs. Youngs and Joyce of the N. Y. Conservation Department gave full time to this project during June, July and the first part of August.

Life History:-Egg laying was observed as early as May 19th and it continued through the entire month of June. The first hatching occurred on June 18th, and most of the larvae had completed their feeding by the middle of August. Although there may have been a few colonies of larvae which completed their growth later than mid-August, it is definite that there was only one generation of the insect in 1944.

Artificial Control:-These experiments consisted of tests of various insecticides making applications before and after hatching, using many different formulas and methods of application. In many plots the entire foliage was sprayed, using knapsack sprayers, and on two areas the insecticide was applied by means of an airplane. In another series of experiments hand atomizers were used in "spot spraying," that is, the various branches having groups of larvae were sprayed with a stomach poison or the larvae were sprayed with a contact insecticide.

Insecticides used and results obtained.

Cryolite:-Concentrated sprays of different dilutions of both the "Karr Formula #2" and the "Potts Formula" did not produce satisfactory results. In every case this insecticide caused buring of the new growth, varying in intensity from severe burn to minor buring of only the needle tips. The action of the poison apparently was too slow in the "spot spraying tests". The results of these experiments prove that cryolite is not efficient in controlling this sawfly.

Lead Arsenate:-This insecticide was used in experiments similar to those in which cryolite was used for the killing agent. The regular formula of four pounds of lead arsenate plus one pint of fish oil to 100 gallons of water proved effective. When this insecticide is applied from knapsack sprayers, the spray deposit on the foliage is sometimes uneven because the agitator does not keep the insecticide in proper suspension.

DDT:-This insecticide produced the most effective results of all materials tested. Two areas in two 9-year old red pine plantations were treated by means of an airplane on the morning of June 30th, when it was estimated that the hatch was about 70 percent completed. The insecticide was prepared according to Dowden's formula--1 part DDT, 1 part cyclohexanone and 7 parts heavy base horticultural spray oil. Complete control was attained. See report of August 22nd for more specific details.

This insecticide was also tested in "spot spraying," making the applications by hand atomizers when the majority of the larvae were in the last feeding instars. The solution was prepared the same as that used in the airplane spraying but was diluted so as to contain different percentages of DDT. The different dosages used and the results as determined by Youngs are as follows:

6 2/3% DDT produced a mortality of 100 percent.
5%, 4%, and 3% DDT produced a mortality of 90 percent.
2% DDT produced a mortality of 75 percent.

Other tests using DDT in "spot spraying" are summarized as follows:

(a) Emulsion of 1 gram DDT, 20 ml ethylene dichloride, 30 ml horticultural spray oil, 30 ml triton (X 100), 10 ml alcohol, plus water to make one quart of liquid, produced a 100 percent kill of the larvae treated.

(b) Emulsion prepared by Dowden, using Ultrol 8 and mixed at rate of 3 pounds DDT to 100 gallons of water produced only a 50 percent kill of the larvae treated.

(c) Emulsion of 1 oz. DDT, 100 ml dichloroethyl ether, 30 ml penetrol and water to make one quart resulted in a 99 percent kill of larvae treated.

(d) Emulsion prepared by Dowden, containing xylene as a solvent, Igepal as emulsifying agent, and DDT at rate of 3 pounds per 100 gallons of solution resulted in 100 percent kill of all larvae treated.

Mercaptoethanol.--One part of this chemical in one quart of water was used in "spot spraying." One hundred forty-nine colonies of larvae on one-tenth acre were treated, using a hand atomizer for application. The results proved this formula was not effective.

Liquid Lime Sulphur:--This was used at the rate of 1 part in 50 parts of water, and it was not effective against the insect.

Conclusions drawn from results of the experimental spraying programs for the control of the red-headed pine sawfly.

Spraying forest plantations by hand methods is too costly except that the so-called "spot spraying" can be recommended for control of this insect on small areas where all trees are less than 10 feet in height. It is possible for one man to "spot spray" four acres in a day where the trees average three feet in height, are planted 6 x 6 feet, and the infestation averages about 500 colonies per acre. It is believed the most practical methods of spraying large acres would be by means of an airplane. Power sprayers furnished with small hose and mist nozzles would be most effective for treating roadside plantings and narrow strips or wind breaks.

Aerosol Bomb:--The bomb contained the following: DDT, 3.0%, pyrethrum extract (20%), 2.0%, cycloheranone, 5.0% lubricating oil (#30), 5.0%, Freon-12, 85.0%. On July 26 in a plot approximately 40 x 60 feet, 60 colonies of nearly fullgrown larvae were treated in 7 minutes. The aerosol was directed toward each group of larvae as the operator walked through the plantation. The larvae showed immediate reaction to the fumes and an 80 percent kill was recorded. There was a rather strong breeze at the time of treatment which may have prevented a 100 percent mortality, especially of some of the larvae in groups near the tops of trees 10 to 12 feet in height.

A test was also made to determine the effective drift of the aerosol. The operator walked between rows of infested red pines for a distance of 25 feet releasing aerosol into quite strong variable winds. The primary effect was only along the first row of trees, with very little effect on the second row at a distance of 5 feet, and no appreciable effect beyond.

Explosive Bombs:--These were compounded by Dr. Glasgow of the New York State Museum, and contained DDT and lead arsenate dusts as the insecticidal ingredients. The bombs were tested early in the morning of July 22nd in a heavily infested plantation of red pine. Unfortunately there was a rather strong breeze and no dew, with the result that there was no adherence of the insecticide. The bombs were exploded, but without results as a control measure. It was our opinion that the bombs were too heavily charged with explosives, especially for plantations where the trees were from 6 to 12 feet in height.

Use of drugs containing bitter elements to render foliage unpalatable to the larvae.--Decoctions of a number of drugs containing bitter elements were tested in the laboratory and there were indications that quassia, senna and aloes when taken up in the sap-stream of red pine caused a heavy mortality of sawfly larvae.

A few small scale tests were made in the field but with the exception of quassia, there was no evidence of beneficial results. The decoctions were poured on the ground around bases of infested trees on June 8 and 10, and there was evidence that quassia caused some mortality but it did not produce complete control.

Crude helenin, tenulin, and quassin furnished by Dr. Haller of the Insecticide Division and some Dithane A-10 He-175 were mixed in water and poured around the infested trees on July 20th while it was raining. Observations were made by Youngs over a period of 18 days following the application and he estimated there had been a mortality of 90 percent. There was no apparent damage to the foliage of the trees or to the ground cover. More tests are needed before definite statements can be made.

Neodiprion n. sp. (The red pine sawfly).

The outbreak in natural stands of red pine near Ausable Forks, N. Y., has persisted; however, no complete defoliation was observed in 1944, and apparently there has been no mortality of trees to date. No observations were made in the Massachusetts and New Hampshire infestations during 1944.

Diprion frutetorum (F.).

Infestations in red pine plantations in Litchfield County, Connecticut, have increased during the past year. Although none of the trees were completely defoliated, larval frass was very noticeable beneath the trees in several 25 to 30 year old plantations. Mr. Dowden has reported on results of airplane spraying with DDT on some of the areas.

The infestation in a 50 acre plantation of 30 year old red pines at Southington, Conn., is now rather light. Although no complete defoliation has ever been recorded in this plantation, the heavy feeding during the past few years has reduced the vitality of many trees so that in one part of the plantation many trees have been attacked by bark beetles, principally Ips grandicollis, and sawyer beetles, Monochamus sp., and have died.

An examination of 1921 cocoons collected in the Southington plantation in 1944 has shown that there was a mortality of 65.5 percent, of which 43 percent was due to the work of Microplectron fuscipennis.

C. Status of work on sawfly investigations.

Sawflies have been increasing in importance as pests of forest plantations in the northeastern States in recent years, and there is a distinct need for the development of preventative as well as more economical control practices. During the summer of 1944 it was determined that there was only one generation of the red-headed pine sawfly in Northern New York; that "spot spraying" with DDT as the insecticide and using hand atomizers for making the application was more economical for controlling this insect on small areas where all trees are less than 10 feet in height; and that DDT in oil distributed from an airplane was most effective for large areas. Although observations were made in a large number of red pine and jack pine plantations in northern New York no evidence was found to indicate that any of the plants of natural reproduction in the plantations had any effect on the infestations of the red-headed pine sawfly. There were some indications that trees growing on the better sites suffered less from this insect, yet on the other hand, there are other areas where the trees are growing on "blow sand" and the infestations have been light to date.

Preliminary experiments indicate that when extracts of certain drugs, having a bitter principle, are applied to the ground around bases of trees enough of the drug may be taken through the roots into the sap-stream to affect the larvae feeding on the foliage.

A program for 1945 to be carried out in cooperation with the New York Conservation Department is being planned. Studies will be made to determine the effectiveness of large scale spraying of DDT from an airplane in the control of this sawfly and the effect it has on populations of other insects commonly found in forest plantations. Further investigations of the possibility of using certain drugs or some of the chemicals that may be taken up in the sap-stream to determine if any are effective and economical for control purposes. As most of the forest plantations owned by the State in northern New York were planted on submarginal or "run out" agricultural land, it is possible that the depletion of one or more of the minor elements commonly found in the soil may have some effect on some of the insect populations. Some investigations will be undertaken in 1945.

Wild Black Cherry Perpetuation Studies. (Schaffner)

A. General conditions affecting completion of program.

This is a long term cooperative project which was established in 1942 on the Harvard Forest, Petersham, Massachusetts. Plans were carried out as outlined for 1944.

Control of the Fall Cankerworm with DDT. (Schaffner)

A. General conditions affecting completion of program.

This project was carried out as planned.

B. Progress during calendar year.

The fall cankerworms (Alsophila pometaria (Harr.)) pupates in the soil beneath the tree upon which it has been feeding. The moths emerge for the most part during the latter half of November and the eggs are deposited in clusters, generally on the upper parts of the tree. As the females are wingless it is necessary for them to crawl to the part of the tree where they lay their eggs.

Tests were made with DDT to determine if spraying parts of trees, over which it would be necessary for the moths to crawl soon after they emerged, would be effective in killing them before they began to lay eggs.

The spray (composed of DDT 1 part, cyclohexanone 1 part and horticultural spray oil 7 parts) was applied November 13th to several species of shade trees in heavily infested areas in Hamden and New Haven, Conn. Each tree was banded with tanglefoot, about five feet above the ground, so that if eggs were laid they could be counted easily. A band about 18 inches to two feet wide was sprayed around the base of some of the trees and on others the entire trunk between the ground and the tanglefoot band was sprayed, using a pint hand atomizer to make the application.

In the area where the trees were sprayed from the ground up to the sticky band there were 30 trees, composed of oaks, hickory and red maple 3 to 14 inches D.B.H. About one quart of the solution was used.

On an area adjoining this treated plot, the owner banded some 20 trees with tanglefoot, but did not spray any of them, so these trees were used as checks. They were comparable as to species and size to those on the sprayed plot.

The results up to and including November 26th are as follows:

Treated plot - 30 trees - 4 small egg masses, all on 2 trees.
Check plot - 20 trees - 383 egg masses, an average of 19.1 per tree.

The total number of egg masses on the treated trees increased to 44 by December 6th, which indicates there was a loss in effectiveness of the DDT because of weathering. There was also a considerable increase in the number of egg masses on the check trees, but because of the over lapping of the eggs just below the sticky bands, it was practically impossible to obtain accurate counts.

In another treated area there were three elm trees (1 to 1½ feet D.B.H.) and 1 sugar maple (4 inches D.B.H.). Each of these had a band about two feet in width sprayed around the trunk near the base, and a record was kept of the dead moths in or beneath the sticky bands, and the new egg masses. The results up to December 5th are as follows:

Elm #1 --------	576	dead	female	moths,	4	small	egg	masses.
" #2 --------	334	"	"	"	3	"	"	"
" #3 --------	659	"	"	"	2	"	"	"
Sugar maple #1-	11	"	"	"	0	"	"	"
	1580	"	"	"	9	"	"	"

Ten trees (2 elm, 1 black oak, 1 red oak, 3 white oak, 2 hickory and 1 apple), varying from 8 inches to 2½ feet D.B.H. were treated in two areas in New Haven. Based on observations made the results are similar to those previously noted.

Notes taken from page 36

b. Aerial application of DDT for the control of forest insects. (Dowden, Holbrook, Schaffner, Potts)

Treatments made during 1944 are summarized in Table 1.

Complete control was obtained against the gypsy moth, the green striped maple worm (Anisota rubicunda (F.)), and the red-headed pine sawfly (Neodiprion lecontei (Fitch)). The same dosage as that used against the gypsy moth, 5 pounds per acre, was used against the green striped maple worm when larvae were from newly hatched to about one-half grown. High larval mortality occurred, and although no final check was made excellent control was indicated. Applications for the control of the red-headed pine sawfly were made on two plots laid out in 9 year old red pine plantations. The degree of infestation varied from light to extremely heavy. Hatching had begun on June 18 and it was estimated that the hatch was about 70 percent completed on the day of spraying. One plot was treated at the same dosage as used on the gypsy moth plots. It was planned to spray the other at the rate of 3½ pounds of DDT in 3½ gallons of spray. Flying conditions caused considerable drift of insecticide, however, and about 11 acres were covered instead of the 7 acres laid out. The second plot was therefore treated with an average of 2¼ pounds of DDT per acre, but the dosage was undoubtedly considerably lighter on the borders of the area. Since complete control was obtained on both areas a dosage at least as low as 2 pounds per acre is sufficient for the control of this insect in young plantations.

Three plots heavily infested with the spruce budworm (Cacoecia fumiferana Clem.) were treated at the Algonquin Provincial Park in Ontario, Canada on June 27. The plots, 8, 12.8 and 9.6 acres in area, were treated with 5, 3 and 2 pounds of DDT per acre respectively. Five gallons of spray per acre were applied on the plot treated with 5 pounds of DDT while 4 gallons of spray were used on the other plots. About 90 percent of the budworms were in the pupal stage at the time of application, about 8 percent were moths and about 2 percent were larvae.

Immediately after the application of DDT large numbers of budworm moths obviously affected by the insecticide were observed fluttering around at the bases of the trees, but there still were many moths in flight which seemed unaffected. The spray was applied under apparently ideal conditions, although there was some "ground fog" and the spray settled very slowly. Glass plates put out on the ground showed very poor coverage. This seemed due to the fact that the coniferous foliage was very dense, particularly near the ground. Some plates with comparatively little foliage immediately over them had a light deposit of DDT crystals. Final results of this work can not be reported on until the spring of 1945 when the young budworms will leave their hibernacula, but it is known that a high population of living larvae went into hibernation.